COMBO: State-of-the-Art Morphosyntactic Analysis

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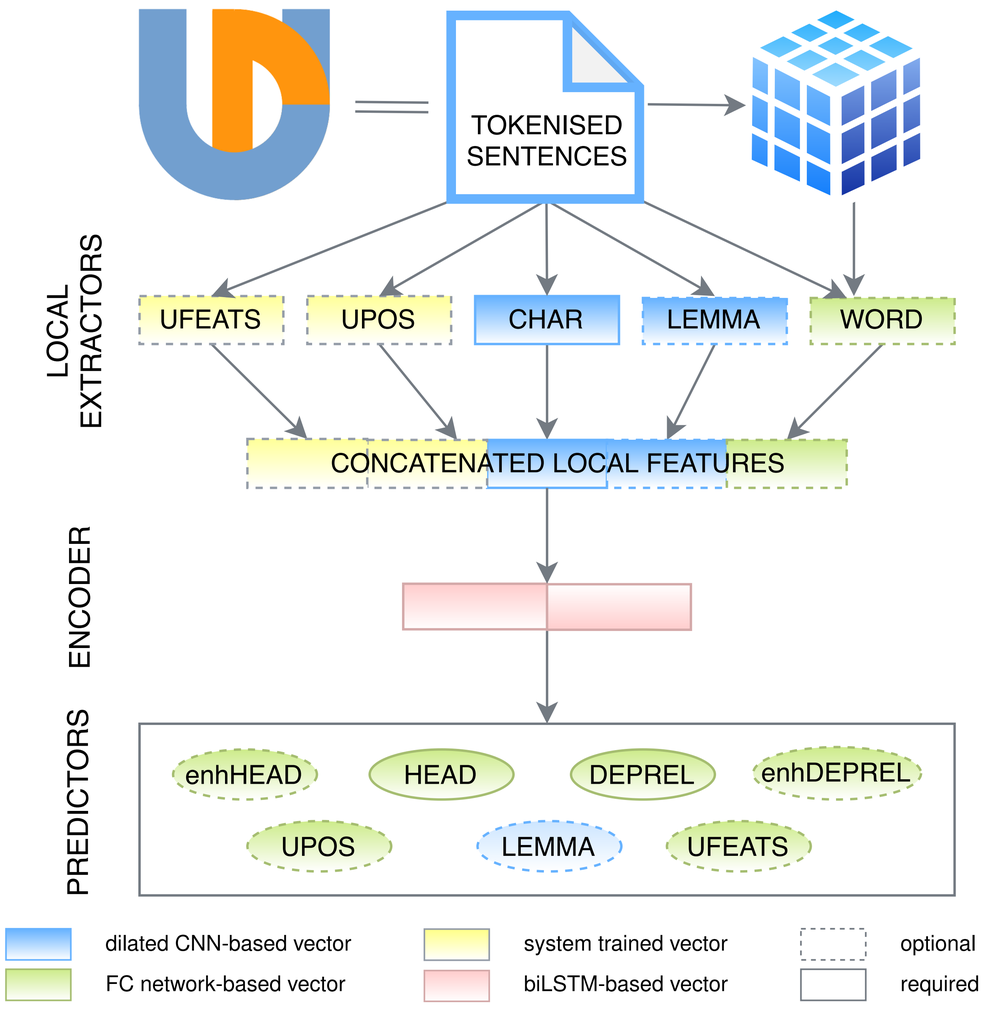
COMBO architecture



Qualitative evaluation (F_1 scores)

System	UPOS	XPOS	UFeat	Lemma	UAS	LAS
UD **English** EWT (isolating)						
spaCy	93.79	93.10	94.89	NA	83.38	79.76
Stanza	96.36	96.15	97.01	**98.18**	89.64	86.89
COMBO	**96.57**	**96.44**	**97.24**	97.86	**91.76**	**89.28**
UD **Arabic** PADT (fusional)						
spaCy	90.27	82.15	82.70	NA	74.24	67.28
Stanza	96.98	93.97	94.08	**95.26**	87.96	83.74
COMBO	**97.04**	**94.83**	**95.05**	93.95	**89.21**	**85.09**
UD **Polish** PDB (fusional)						
spaCy	96.14	86.94	87.41	NA	86.73	82.06
Stanza	98.47	94.20	94.42	97.43	93.15	90.84
COMBO	**98.97**	**96.54**	**96.80**	**98.06**	**95.60**	**93.93**
UD **Finnish** TDT (agglutinative)						
spaCy	92.15	93.34	87.89	NA	80.06	74.75
Stanza	97.24	97.96	95.58	**95.24**	89.57	87.14
COMBO	**98.29**	**99.00**	**97.30**	89.48	**94.11**	**92.52**
UD **Korean** Kaist (agglutinative)						
spaCy	85.21	72.33	NA	NA	76.15	68.13
Stanza	95.45	**86.31**	NA	**93.02**	88.42	86.39
COMBO	**95.89**	85.16	NA	89.95	**89.77**	**87.83**

COMBO system

- functional:
  - fully neural
  - predicts categorical morphosyntactic features and exposes their vectors
  - easy to install Python package that uses the PyTorch and AllenNLP libraries
- multipurpose:
  - part-of-speech tagging
  - morphological analysis
  - lemmatisation
  - (enhanced) dependency parsing
- accessible:
  - open-source code (GNU GPL v3.0)
  - pre-trained models for over 40 languages
- efficient:
  - fast model training
  - state-of-the-art prediction quality.

Downstream evaluation (accuracy)

- Task: textual entailment in English and Polish
- Entailment classifier: neural network with two FC layers
- Tested sentence representations:
  - max/mean-pooled BERT embeddings (baseline)
  - morphosyntactically informed BERT embeddings transformed by a network with two transformer layers

Language	max-pooled	mean-pooled	COMBO-based
English	58.1	73.4	78.8
Polish	74.4	83.9	91.6

Efficiency evaluation – training time

Treebank	spaCy	Stanza				COMBO
		Tagger	Lemmatiser	Parser	Total	
English EWT	00:22:34	02:08:51	02:12:17	02:29:13	06:50:21	1:54:11
Polish PDB	01:07:55	04:36:51	03:19:04	05:08:41	13:04:36	3:31:41

Getting started with COMBO

Python

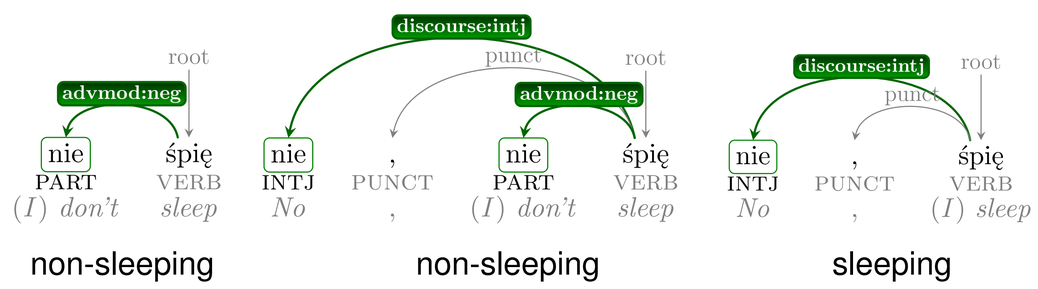
```
from combo.predict import COMBO

nlp = COMBO.from_pretrained("polish")
sentence = nlp("Ala ma kota.")
print(sentence.tokens)
print(sentence.tokens[1].embeddings['upostag'])
```

CLI

```
combo --mode predict \
      --model_path model.tar.gz \
      --input_file input.conllu \
      --output_file output.conllu
```

Why do we need morphosyntactic features?



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Code available at: